June 7, 1888.

Professor G. G. STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I.* "Note on some of the Motor Functions of certain Cranial Nerves (V, VII, IX, X, XI, XII), and of the three first Cervical Nerves, in the Monkey (*Macacus sinicus*)." By CHARLES E. BEEVOR, M.D., F.R.C.P., and VICTOR HORSLEY, B.S., F.R.S. (From the Laboratory of the Brown Institution). Received May 16, 1888.

In the course of an investigation which we are making into the cortical representation of the muscles of the mouth and throat, we have experienced considerable difficulty in describing correctly the movements of these parts, especially when there was any question of bilateral action occurring.

On referring to text-books we failed to find any solution of this difficulty, and we therefore determined to make a few observations of the movements evoked by stimulating the several cranial nerves supplying this region in the monkey† so as to have a definite basis whereon to ground our observations of the movements obtained by stimulating the cortex.

In the course of this work we have observed several facts which do not harmonise with the views hitherto generally received.

The results are summarised as follows:—

Method of Investigation.

The foregoing summary of our experiments is based almost entirely upon the results obtained by exciting the respective nerves at the base of the cranial cavity after separating them from the bulb.

We have also stimulated the nerves outside the skull in the neck both before and after division.

* Towards the expenses of this research a grant was made by the British Medical Association, on the recommendation of the Scientific Grant Committee of the Association.

† Previous observers having employed animals of lower orders.

In every case the animal was narcotised with ether.

(1.) For the exposure of the nerves at the base of the cranial cavity it was found possible to rapidly remove a cerebral hemisphere, clamping the carotid and other arteries, then to divide the tentorium and to remove the major part of the cerebellar hemisphere of the same side, so as to admit of prolonged and numerous observations before the animal died. In all we have made eight experiments, and in every case we have operated on the same kind of monkey, *i.e.*, *Macacus sinicus*.

(2.) For the exposure of the nerves outside the skull we found it easy to lay bare the upper cervical nerves and those of the cranial division in the anterior triangle by turning forward a triangular flap of skin, ligaturing and removing the external jugular vein, and dividing and turning aside completely the sternomastoid muscle. Finally, the parotid gland and digastric muscle (posterior belly) were drawn up with hooks, the head being turned to the opposite side.

The chorda tympani was readily exposed without injury, in the tympanic cavity, *before* the dissection of the triangle by cutting away the posterior wall of the external auditory meatus and the posterior half of the tympanic ring. The facial nerve was subsequently exposed in the stylomastoid foramen and aqueduct.

The nerves were in each case raised up from their position and stimulated in the air by the faradic current through fine platinum electrodes, the area of the operation having been gently dried.

The current employed was from the secondary coil of an ordinary du Bois-Reymond inductorium, supplied by a 1 litre bichromate cell. The experiment was carefully begun with the secondary coil at a distance of 30 cm. from the primary, this interval being very rarely diminished to more than 15 cm. (zero being of course the point where the secondary coil completely overlaps the primary).

Further Observations respecting the Examination of each Nerve.

A. *Cranial Division.*

Vth Nerve.—Excitation of the motor root of the trigeminus evoked powerful closure of the jaws, and although the muscles of one side only were in action, the teeth were approximated without any lateral deviation of the lower jaw.

VIIth Nerve.—The motor distribution of the facial nerve has for the most part been well known for some time. However, we consider that, unfortunately, a very fundamental error respecting this distribution has crept into the text-books, it being supported by one anatomical authority following another, and, moreover, having been accepted by clinicians as an important aid in the differential diagnosis of facial paralysis. We refer to the supposed supply of motor fibres

from the facial to the levator palati through the superficial petrosal nerve.

This idea,* upon which so much stress has been laid, is entirely hypothetical, as might have been shown at any time by stimulating the facial nerve in the skull, and observing the soft palate.

We have found that stimulation of the peripheral end of the divided facial nerve in the internal auditory meatus failed to cause even with most powerful currents the slightest movement of the soft palate, although the face was thrown into violent spasm. The true motor nerve supply of the levator palati is, according to our observations, the XIth nerve (*vide infra*).

IXth Nerve. Glossopharyngeal.—In exciting this nerve, in addition to the movements of the pharynx, which we attribute to the contraction of the stylopharyngeus, and possibly to the middle constrictor of the pharynx, we have observed certain movements of the palate, as follows:—(I.) Stimulation of the nerve while beneath the stylohyoid ligament and uncut, gave in two instances elevation of the palate on the same side, and in one instance on both sides. We suppose that everyone will consider with us this movement to be reflex in origin, but we must add (II) that in one case we saw elevation of the palate to the same side when exciting the peripheral end of the cut nerve. In this latter case, perhaps, the result may be explained by the close neighbourhood of the pharyngeal plexus and the possible escape of current thereto, and under any circumstances this is but a single exceptional observation, so that we lay no stress upon it. Finally we never saw movement of the soft palate when the glossopharyngeal nerve was stimulated within the cranial cavity.

Xth Nerve. Vagus.—In stimulating the uncut nerve outside the skull, below the level of its junction with the hypoglossal, rhythmical movements of swallowing were produced, which occurred at the rate of twenty-five times in thirty-five seconds.

In one observation all the constrictors of the pharynx were thrown into action, when the peripheral end of the cut nerve was stimulated outside the skull.

The rhythmical movements of swallowing obtained by stimulating this nerve must be due to, of course, the simple reflex, the stimulus acting on the nerve in the centripetal direction, and that this was the case is proved by the fact that no movement was obtained when the peripheral end of the cut nerve was stimulated inside the skull.

* Without definitely supporting this view, Gaskell ('Roy. Soc. Proc.,' vol. 43, p. 390) shows that some large "somatic" nerve-fibres leave the facial nerve between its origin from the bulb and its exit from the stylomastoid foramen. He suggests that some of them may possibly form a nerve to supply the levator palati, but he leaves their real destination undetermined.

The superior laryngeal branch on being stimulated gave rhythmical movements of swallowing at the rate of seventeen times in fifteen seconds, but when the nerve was cut and its peripheral end stimulated, only very slight movement was produced in the larynx, evidently by contraction of the cricothyroid muscle.

XIth Nerve. Accessory to Vagus.—In discussing the motor functions of the VIIth nerve, we stated that the hitherto received idea of the soft palate being supplied by the facial nerve was, according to our observations, entirely erroneous. We find that the levator palati is supplied entirely by the XIth nerve.* When the peripheral end of the cut nerve was stimulated inside the skull, elevation of the soft palate on the same side was invariably seen. The path by which the fibres from this nerve reach the palate is probably through the upper branch of the pharyngeal plexus.

XIIth Nerve. Hypoglossal.—When the entire nerve was excited outside the skull, just below the point where it is joined by the first cervical nerve, the tongue was flattened posteriorly on the same side, and the tip protruded also on the same side, while in no case was there any heaping up of the tongue.

At the same time the depressors of the hyoid bone were thrown into action, and in some cases this dragging downwards of the hyoid completely prevented the tongue from being protruded.

The movements described above were repeated without alteration when the peripheral end of the cut nerve was excited at the same place.

It must be particularly noted that the movements of the tongue were purely uni-lateral, and this was proved to be the case beyond doubt by two experiments, in which the tongue was divided longitudinally in the middle line to the hyoid bone when the movements were seen to be entirely confined to the side stimulated.

When the cut nerve was excited within the skull a different result was obtained, the tongue was flattened behind, and protruded towards the same side, but there was no action in the depressors of the hyoid.

It has always been held that the depressors of the hyoid bone receive their motor nerve supply from the hypoglossal through the descendens noni, but, as will be shown further on, according to our observation, these muscles are supplied by the first and second cervical nerves, and it is only when the hypoglossal is stimulated below the point where it is joined by the branch from the first cervical nerve, that any movement is produced in the depressors of the hyoid.

* I desire to add here that Dr. Felix Semon, in the course of some experiments (unpublished), performed in conjunction with myself, found that in the dog the levator palati was innervated by the XIth nerve.—V. H.

B. *Spinal Division.*

Our observations of the motor functions of the first three cervical nerves as regards their influence on the hyoidean muscles have been made when the nerves have been excited—

(*a.*) In the spinal canal.

(*b.*) In the neck immediately upon their exit from between the vertebral transverse processes.

The nerves in the spinal canal were separated from the spinal cord and thoroughly dried, the efficacy of the precautions taken against spread being evidenced by the difference in result obtained by exciting each root.

The effects obtained by the methods *a* and *b* were identical.

Ist Cervical Nerve. Branch of Union with the Hypoglossal.—In the description of the XIIth cranial nerve, we have stated as the result of our experiments that the depressors of the hyoid bone are not thrown into action when this nerve is stimulated within the skull. On carefully dissecting out the branch from the Ist cervical nerve to the hypoglossal we find on excitation of it that there is no movement in the tongue, but the depressors of the hyoid bone are strongly contracted. Of these muscles the sterno-hyoid and sterno-thyroid were always especially affected, while the omo-hyoid was less frequently seen to contract and in some cases not at all. In the cases where this muscle contracted, in one experiment the anterior belly alone acted, and when both bellies contracted the movement in the anterior was in excess of the posterior.

IInd Cervical. Branch to the Descendens Noni.—On stimulating this nerve the depressors of the hyoid were thrown into action, but the muscles involved were not affected in the same way as was the case with the Ist cervical nerve. The muscle which was most constantly set in action by excitation of the IInd cervical nerve was the omo-hyoid and especially its posterior belly. The sterno-hyoid and sterno-thyroid also took part in depressing the hyoid bone, but it was especially remarked in half the cases, that their action was notably less powerful than that of the omo-hyoid. In one experiment in which a very weak current was employed, the omo-hyoid was alone seen to contract. We are consequently led to conclude that while the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles are all set in action by excitation of the Ist and IInd cervical nerves, the first two muscles are relatively supplied by the former nerves, while the IInd nerve is especially connected with the omo-hyoid muscle.

Descendens Noni.—We prefer to mention here the results of exciting this nerve, inasmuch as we regard its motor fibres to be derived entirely from the Ist and IInd cervical nerves. This nerve

(ordinarily regarded as a branch of the XIIth cranial), when stimulated above its junction with the branch from the IInd cervical nerve, produced contraction of the sterno-hyoid and sterno-thyroid muscles, and where the current employed was weak there was no contraction of the omo-hyoid, but this movement was superadded on increasing the strength of the current.

We ought here to mention the opinion held by Volkmann (*loc. cit.*, *infra*) that fibres ascend to the hypoglossal from the spinal rami communicantes by the descendens noni.

IIIrd Cervical Nerve.—On stimulating the branch from this nerve, which forms the IInd cervical nerve just before the ansa thus formed is connected to the descendens noni, there was no action seen in the depressors of the hyoid bone; it therefore seems certain that these muscles are supplied with motor fibres solely by the branches from the Ist and IInd cervical nerves.

Summary of Results.

Cranial nerves.	Reference.	Views previously held.	Authors' views.
V. Trigeminus.	All authors.	Muscles of mastication.	Ditto.
VII. Facial.	Hermann, 'Physiology.'	Muscles of face, stylo-hyoid, levator palati, digastric (posterior belly), stapedius, platysma myoides.	In agreement, except with regard to the levator palati, for which see XIth nerve.
	Quain's 'Anatomy,' 9th edition.	Muscles of face and of tympanum, the levator palati, azygos uvulæ (through the large superficial petrosal nerve).	
	Ellis' 'Anatomy,' 10th edition.	"Supposed" to send motor fibres to Meckel's ganglion and so to palate.	
	Bastian, 'Cerebral and Bulbar Paralysis.'	Expresses great doubt as to the superficial petrosal nerve supplying the soft palate.	
	Hughlings Jackson.	*Vide* XIth nerve.	
	Volkmann, 'Müller's Archiv,' 1840, p. 475.	No movement of soft palate.	
	Hein, 'Müller's Archiv,' 1844, p. 297.	No movement of soft palate.	

Summary of Results—*continued.*

Cranial nerves.	Reference.	Views previously held.	Authors' views.
Chorda tympani.	Hermann, *loc. cit.*	Secretory and (?) gustatory functions.	In agreement with secretory functions; certainly *not* motor.
	Quain, *loc. cit.*	Submaxillary gland and "tongue."	
	Bastian, *loc. cit.*	Secretory and gustatory functions.	
IX. Glossopharyngeal.	Hermann, *loc. cit.*	Levator palati, azygos uvulæ, middle constrictor of pharynx, stylopharyngeus.	Stylopharyngeus, (?) middle constrictor of pharynx.
	Quain, *loc. cit.*	Stylopharyngeus.	
	Bastian, *loc. cit.*	Middle constrictor of pharynx, stylopharyngeus, azygos uvulæ, levator palati.	
	Volkmann, *loc. cit.*	Middle constrictor of pharynx, stylopharyngeus.	
X. Vagus. XI. Accessory.	Hermann, *loc. cit.*	Muscles of soft palate and pharynx, larynx, and alimentary canal.	X. Vagus, nil motor in neck and head.
	Quain, *loc. cit.*	"Combined X and XI" form the pharyngeal plexus . . . which supplies the muscles and mucous membrane of larynx.	
	Hein, *loc. cit.*	Movements of soft palate.	
	Bastian, *loc. cit.*	The larynx, pharynx, &c.	
X. Vagus (only).	Volkmann, *loc. cit.*	Levator palati, azygos uvulæ (goat), constrictors of pharynx (superior and inferior), palato-pharyngeus, laryngeal muscles.	
	Chauveau, quoted by Vulpian.	Do. (donkey and horse).	
	Vulpian, 'Comptes Rendus,' vol. 103, 1886.	Do. (dog).	
XI. Accessory to vagus.	Bastian, *loc. cit.*	In all probability it supplies the levator palati.	Excitation of it produces elevation of soft palate on same side, in addition

Summary of Results—*continued.*

Cranial nerves.	Reference.	Views previously held.	Authors' views.
			to movements of the pharynx, larynx, &c., as stated by other authors.
	Hughlings Jackson, 'London Hospital Rep.,' vol. 1, p. 335, 1864.	Denies that motor fibres of soft palate come from facial nerve, and supports the belief that they come from vagus, or its accessory nerve.	
XII. Hypoglossal.	Hermann, *loc. cit.*	Muscles of tongue, muscles connected with hyoid bone, and it receives sensory fibres through its ramus descendens from the first cervical nerves.	Intrinsic muscles of tongue of the same side only. *Not* the depressors of hyoid bone.
	Quain, *loc. cit.*	It supplies, alone or in union with spinal nerves, the tongue, muscles, and depressors of the hyoid bone.	
	Volkmann, *loc. cit.*	As a rule no movement in depressors of hyoid, but the sterno-hyoid was seen to contract on intracranial excitation in two calves and one dog.	
	Bastian, *loc. cit.*	Motor to tongue and most of the muscles attached to hyoid bone.	

Cervical nerves.	Reference.	Views previously held.	Authors' views.
I.	All authors. Volkmann, *loc. cit.*	Nil save posterior neck muscles. Sterno-hyoid and sterno-thyroid supplied.	I. Depressors of hyoid, especially sterno-hyoid and sterno-thyroid.
II. III.	Hermann, *loc. cit.* Quain, *loc. cit.* Bastian, *loc. cit.*	"Supply" infra-hyoid muscles with descendens noni.	II. Depressors of hyoid, especially omo-hyoid. III. Nil motor.
II (alone).	Other authors. Volkmann, *loc. cit.*	Supplies the small muscles of neck, but not the depressors of hyoid.	

II. "An Additional Contribution to the Placentation of the Lemurs." By Professor Sir Wm. Turner, Knt., M.B., LL.D., F.R.S. Received May 21, 1888.

In 1876 I contributed to the Royal Society a memoir "On the Placentation of the Lemurs," which was published in the 'Philosophical Transactions' of that year (vol. 166, Part 2). The gravid uteri which I examined and described were from specimens of *Propithecus diadema*, *Lemur rufipes*, and *Indris brevicaudatus*. The examination showed in these Lemurs that the placental villi were diffused over the greater part of the surface of the chorion, so as to approximate in general plan with the arrangement in the Pig, Mare, and Cetacean, though of course with special characters of their own; that there were also distinct areas on the chorion free from villi; that the uterine mucous membrane possessed multitudes of crypts, from out of which the villi were easily drawn; that smooth patches of mucous membrane devoid of crypts, and corresponding to the non-villous parts of the chorion were present, towards which the stems of the uterine glands converged in a remarkable manner, and on the surface of which they opened by obliquely directed mouths in considerable numbers. Further, it was pointed out that the chorion occupied both horns of the uterus, though the part which was prolonged into the non-gravid horn was only a short diverticulum, and that the allantois formed a large persistent sac, which, like the sac of the amnion, did